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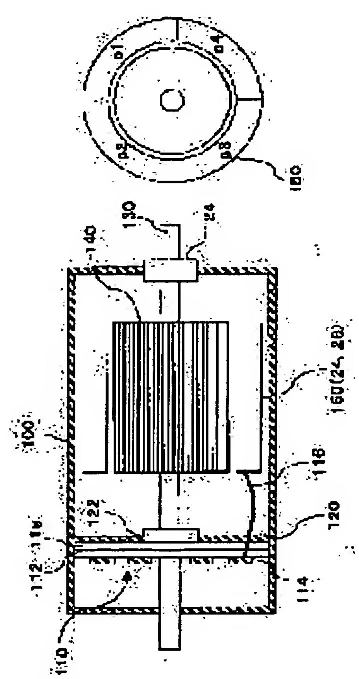
(54) DRIVE DEVICE INTEGRATED WITH INVERTER

(57)Abstract:
PROBLEM TO BE SOLVED: To make a drive device using an inverter compact.
SOLUTION: A battery is connected to a neutral point of a stator coil 150, and a capacitor is connected to the input side of an inverter 110 where an output terminal is connected to the stator coil 150. The stator coil 150 is used as a boosting converter. The inverter 110 and a motor in this constitution are stored in one housing 100.



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CLAIMS

[Claim(s)]
[Claim 1] The coil of a star, and the terminal for cells for connecting at the neutral point of this coil and connecting with a cell, The inverter which an output side is connected to the edge of said coil, changes the direct current power of an input side into a polyphase current, and is supplied to a coil, The terminal for capacitors for connecting with the input side of this inverter and connecting with the capacitor which supplies direct current power to an inverter, The inverter one apparatus driving gear which an implication and these are held in one case and can convey the power of a cell to said capacitor through a coil and an inverter.
[Claim 2] The 1st coil of a star, the 2nd coil of a star, and the terminal for cells of the pair for connecting at the neutral point of these 1st and 2nd coils, respectively, and connecting a cell during the neutral point of a pair, The 1st inverter which an output side is connected to the edge of said 1st coil, changes the direct current power of an input side into a polyphase current, and is supplied to the 1st coil, The 2nd inverter which an output side is connected to the edge of said 2nd coil, changes the direct current power of an input side into a polyphase current, and is supplied to the 2nd coil, The 2nd terminal for connecting with the input side by which common connection of these 1st and 2nd inverters was made, and connecting with a capacitor, The inverter one apparatus driving gear which an implication and these are held in one case and can convey the power of a cell to said capacitor through the 1st and 2nd coils and the 1st and 2nd inverters.
[Claim 3] The inverter one apparatus driving gear which approaches said 1st coil and 2nd coil, arranges one Rota in equipment according to claim 2, and carries out the rotation drive of one Rota with said 1st and 2nd coils.
[Claim 4] The inverter one apparatus driving gear which the maximum amplitude value of the current supplied to one coil of the coils of the 1st and 2nd stars is decreased in equipment according to claim 2 or 3, and adds the current corresponding to the decrement to the current supplied to the coil of another side.

[Translation done.]

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the inverter one apparatus driving gear which has a pressure-up function while building in an inverter and a coil.
[0002]
[Description of the Prior Art] Conventionally, direct current power is changed into an alternating current with an inverter, and the system which drives an AC motor has spread. In this system, the current supply source to an AC motor can be controlled by control of an inverter broadly and easily, and it is widely used by various kinds of applications. For example, in an electric vehicle or a hybrid car, the direct current power from the carried cell is changed into desired alternating current (it responded to the output-torque command) with an inverter, and the drive motor is supplied. In addition, regeneration power can also be used for charge of a cell in this system, and it is very advantageous.
[0003] Here, between an inverter and a motor, wiring with which a big current flows is required, and arranging to near if possible is called for. In the case of the motor especially carried in a car, to be collected into the compact is demanded.
[0004] Then, the inverter one apparatus motor which held the inverter and the motor in one case is known from the former. According to this configuration, leading about of wiring also becomes easy and can be constituted in a compact as a whole.
[0005]
[Problem(s) to be Solved by the Invention] Here, the direct current voltage from a cell is supplied to an inverter, and an inverter changes this into it at an alternating current. It is necessary to generate big torque and the output of a motor becomes very large by the motor for cars at the time of start etc. In such a case, if cell voltage is low, the current value for obtaining the output will become very large, and an energy loss will become large. Then, I want to make cell voltage sufficiently high. Although fluctuation of cell voltage can be controlled if cell capacity is enlarged enough, it is difficult to enlarge cell capacity very much, and changing cell voltage is not avoided.
[0006] On the other hand, cell voltage is comparatively made into the low battery, and the system made into the high voltage is also known using the pressure-up converter. According to this system, cell voltage is comparatively made to a low battery, and inverter input voltage and motor input voltage can be maintained to the high voltage.
[0007] However, a pressure-up converter requires the coil other than a switching transistor. Then, uniting such a pressure-up converter with a motor took the location on the contrary, and it had the problem that the installation became difficult.
[0008] It aims at offering the inverter one apparatus driving gear which can be formed in a compact, this invention being made in view of the above-mentioned technical problem, and having a pressure-up function.

[0009]
[Means for Solving the Problem] The terminal for cells for this invention being connected with the coil of a star at the neutral point of this coil, and connecting with a cell, The inverter which an output side is connected to the edge of said coil, changes the direct current power of an input side into a polyphase current, and is supplied to a coil, The terminal for capacitors for connecting with the input side of this inverter and connecting with the capacitor which supplies direct current power to an inverter, An implication and these are held in one case and it is characterized by it being possible to convey the power of a cell to said capacitor through a coil and an inverter.

[0010] Thus, the pressure up of the power of a cell can be conveyed and carried out to a capacitor by connecting a cell at the neutral point of a coil. And in spite of having such a pressure-up function, the pressure-up converter of another object is unnecessary, and can obtain an inverter one apparatus driving gear.
[0011] This invention Moreover, the 1st coil of a star and the 2nd coil of a star, The terminal for cells of the pair for connecting at the neutral point of these 1st and 2nd coils, respectively, and connecting a cell during the neutral point of a pair, The 1st inverter which an output side is connected to the edge of said 1st coil, changes the direct current power of an input side into a polyphase current, and is supplied to the 1st coil, The 2nd inverter which an output side is connected to the edge of said 2nd coil, changes the direct current power of an input side into a polyphase current, and is supplied to the 2nd coil, The 2nd terminal for connecting with the input side by which common connection of these 1st and 2nd inverters was made, and connecting with a capacitor, An implication and these are held in one case and it is characterized by it being possible to convey the power of a cell to said capacitor through the 1st and 2nd coils and the 1st and 2nd inverters.
[0012] Thus, with the equipment which connects a cell during the neutral point of the star coil of a pair, the potential difference during the two neutral points of a star coil is only specified, and the average potential (neutral point potential) of each star coil itself can be set as arbitration. Then, broad control can be performed about a capacitor electrical potential difference (inverter input voltage).
[0013] Moreover, it is suitable to approach said 1st coil and 2nd coil, to arrange one Rota, and to carry out the rotation drive of one Rota with said 1st and 2nd coils.
[0014] Moreover, it is suitable to decrease the maximum amplitude value of the current supplied to one coil of the coils of the 1st and 2nd stars, and to add the current corresponding to the decrement to the current supplied to the coil of another side.
[0015] By this configuration, maximum current can be reduced, an inverter and a coil can also be made small, and a suitable one apparatus driving gear can be obtained.
[0016]
[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained based on a drawing.
[0017] Drawing 1 is drawing showing the circuitry of the whole system containing the inverter one apparatus motor concerning this invention. This configuration is the same as that of what was proposed in the application for patent No. 331175 [2001 to].
[0018] Namely, 2 coil motor 22 which has two three phase coils 24 and 26 with which Y connection (star) of the power output unit 20 shown in drawing was carried out (henceforth 2Y motor), Two inverter circuits 30 and 32 which are respectively connected to two three phase coils 24 and 26, and share the positive-electrode bus-bar 34 and the negative-electrode bus-bar 36, It has the capacitor 38 connected to the positive-electrode bus-bar 34 and the negative-electrode bus-bar 36, DC power supply 40 prepared during the neutral point of two three phase coils 24 and 26 of the 2Y motor 22, and the electronic control unit 50 which controls the whole equipment.
[0019] Drawing 2 is an explanatory view which illustrates the relation of two three phase coils 24 and 26 of the 2Y motor 22. The 2Y motor 22 consists of Rota where the permanent magnet was stuck on the outside surface, and a stator which only the include angle alpha shifted two three phase coils 24 and 26 to the hand of cut, and was wound so that it might illustrate to drawing 2 , and is carrying out the same configuration as the synchronous generator motor in which the usual generation of electrical energy is possible except for the point that two three phase coils 24 and 26 are wound. Since only the include angle alpha has shifted to the hand of cut, the three phase coils 24 and 26 can also consider the 2Y motor 22 to be the motor of a six phase. What is necessary is just to control an inverter circuit 32 so that the three-phase alternating current in which only the coil gap angle alpha had phase contrast to the three-phase alternating current impressed to the three phase coil 24 by the inverter circuit 30 is impressed to the three phase coil 26 in order to drive such a 2Y motor 22. In addition, the revolving shaft of the 2Y motor 22 is the output shaft of the power output unit 20 of an example, and power is outputted from this revolving shaft. Since it is constituted as a generator motor as mentioned above, the 2Y motor 22 of an example can be generated by the 2Y motor 22, if power is inputted into the revolving shaft of the 2Y motor 22.
[0020] Both the inverter circuits 30 and 32 are constituted by six diodes D11-D16, and D21-D26. [six transistors T11-T16, T21-T26, and] Six transistors T11-T16, and two T21-T26 are arranged at a time in a pair so that it may become a source and sink side to the positive-electrode bus-bar 34 and the negative-electrode bus-bar 36, respectively, and each of the three phase coils 24 and 26 (UVW) of the 2Y motor 22 is

connected at the node. Therefore, if the rate of transistors T11-T16 and the ON time amount of T21-T26 of making a pair is controlled by the condition that the electrical potential difference is acting on the positive-electrode bus-bar 34 and the negative-electrode bus-bar 36, with the phase contrast of the coil gap angle alpha, rotating magnetic field can be formed with the three phase coils 24 and 26 of the 2Y motor 22, and the rotation drive of the 2Y motor 22 can be carried out.
[0021] Moreover, in this operation gestalt, two three phase coils 24 and 26 may be arranged separately, Rota corresponding to each may be prepared, and you may completely constitute as two another motors.
[0022] The electronic control unit 50 is constituted as a microprocessor centering on CPU52, and is equipped with ROM54 which memorized the processing program, RAM56 which memorizes data temporarily, and input/output port (not shown). In this electronic control unit 50 The neutral point current Io from the current sensor 67 attached at the neutral point of the each phase currents Iu1, Iv1, Iw1, Iu2, Iv2, and Iw2 from current sensors 61-66 and the 2Y motor 22 which were attached in each phase of uvw of the three phase coils 24 and 26 of the 2Y motor 22, The electrical potential difference Vc between terminals of the capacitor 38 from a voltage sensor 70 attached in the angle of rotation theta and capacitor 38 of a rotator of the 2Y motor 22 from the angle-of-rotation sensor 68 attached in the revolving shaft of the 2Y motor 22, the command value about the drive of the 2Y motor 22, etc. mind input port. It is inputted. Here, any one is respectively good also as a thing of current sensors 61-63 and the current sensors 64-66 which can omit and uses any one as a sensor only for malfunction detection. Moreover, from the electronic control unit 50, the control signal for performing the transistors T11-T16 of inverter circuits 30 and 32 and switching control of T21-T26 etc. is outputted through the output port.
[0023] "the capacitor armature-voltage control in 2YDC" -- as mentioned above, with this operation gestalt, DC power supply have been arranged during the two neutral points of a polyphase coil, and the electrical potential difference of the capacitor 38 which is the power source of two inverter circuits 30 and 32 was controlled by controlling switching of the inverter circuits 30 and 32 which control the electric power supply to two polyphase coils.
[0024] Here, if the interior of an inverter is omitted and 2YDC system of this operation gestalt is rewritten, it can express like drawing 3 .
[0025] That is, the end of Capacitor C is connected to the power source (for example, ground) of a fixed electrical potential difference. And the both ends of this capacitor C are connected to the inverter INV1 and the inverter INV2, respectively. That is, the output of Capacitor C is inputted into inverters INV1 and INV2 as a power source.
[0026] An inverter INV1 has the outputs U1, V1, and W1 of a three phase circuit, and the coil of the three phase circuit of U, V, and W of the motor coil M1 is connected here, respectively. Moreover, an inverter INV2 has the outputs U2, V2, and W2 of a three phase circuit, and the coil of the three phase circuit of U, V, and W of the motor coil M2 is connected here, respectively.
[0027] Here, although the motor coils M1 and M2 are shown separately, it is the coil of one motor as mentioned above, and it is arranged so that only predetermined include angles may differ on a motor in the usual case, and the current of the phase from which only the predetermined include angle differs is supplied. By this, both currents supplied to both the motor coils M1 and M2 function as a motorised current.
[0028] Common connection of each phase motor coil of the motor coils M1 and M2 is made in the neutral point, and the neutral points of the motor coils M1 and M2 are connected through Dc-battery B. In this example, the positive electrode of Dc-battery B is connected at the neutral point of the motor coil M1, and the negative electrode of Dc-battery B is connected at the neutral point of the motor coil M2.
[0029] In addition, although illustration was omitted, inverters INV1 and INV2 have three arms which consist of series connection of two switching transistors arranged between the 1st power source p and the 2nd power source m (the 1st power source p grounds in the example of illustration), respectively, and the middle point of these arms is connected to each phase end winding.
[0030] Therefore, by controlling turning on and off of the switching transistor in inverters INV [INV1 and] 2, a desired current can be supplied to the motor coils M1 and M2 from Capacitor C, and these can be driven. Furthermore, currents other than the phase current for motorised [which goes in and out from the neutral point in the motor coils M1 and M2] (zero phase current) are controlled by distinguishing between the die length of the "on" period of the top transistor in inverters INV1 and INV2, and the "on" period of a bottom transistor.
[0031] Here, with this operation gestalt, inverters INV1 and INV2 drive by using the both-ends electrical potential difference (output voltage) Vc of one capacitor C as a power source. And the both-ends electrical potential difference (output voltage) E of Dc-battery B is not changed fundamentally. Then, the middle point

potential of the motor coils M1 and M2 can be set as arbitration by controlling the zero phase current, maintaining the difference only for an electrical potential difference of Dc-battery B.

[0032] As shown in drawing 3 , the electrical potential difference of the 1st power source p the electrical potential difference of **** and the 2nd power source m In addition, Vm, The output current of Capacitor C ic and the both-ends electrical potential difference of Capacitor C Vc (=|Vm-****|), For the current from the 1st power source p of an inverter INV1, ip1 and the current from the 2nd power source m of an inverter INV1 are [ip2 and the current from the 2nd power source m of an inverter INV2 of im1 and the current from the 1st power source p of an inverter INV2] im2. Moreover, they are [coil / M1 / motor] the u phase current iu2, the v phase current iv2, the w phase current iw2, u **** electrical potential difference Vu2, v **** electrical potential difference Vv2, and w **** electrical potential difference Vw2 about the u phase current iu1, the v phase current iv1, the w phase current iw1, u **** electrical potential difference Vu1, v **** electrical potential difference Vv1, w **** electrical potential difference Vw1, and the motor coil M2. For the neutral point electrical potential difference of the motor coil M1, the neutral point electrical potential differences of Vz1 and the motor coil M2 are [E and the zero phase current of Vz2 and a dc-battery B electrical potential difference] ie(s).

[0033] In this system, especially the relation of the neutral point potentials Vz1 and Vz2 of the motor coils M1 and M2 and the supply voltage Vc of inverters INV1 and INV2, i.e., the output voltage of Capacitor C, becomes settled in the ratio of the "on" period of the top transistor in inverters INV1 and INV2, and a bottom transistor, and the potential difference during the two neutral points of the motor coils M1 and M2 is the dc-battery B electrical potential difference E (=|Vz1-Vz2|). Therefore, the both-ends electrical potential difference of Capacitor C will be determined by the ratio (percent modulation) of the "on" period of the top transistor of inverters INV1 and INV2, and a bottom transistor.

[0034] Moreover, inverters INV1 and INV2 control the neutral point potentials Vz1 and Vz2 of the motor coils M1 and M2 by carrying out PWM control of the internal switching transistor. Here, the ratio (percent modulation) of the "on" period of a top transistor and the "on" period of a bottom transistor is the rate of the amplitude of an electrical-potential-difference command value to a round term of the subcarrier which is a triangular wave, as shown in drawing 4 (a) and 4 (b). That is, if an electrical-potential-difference command value is made high, the period when a triangular wave exceeds a command value so much will decrease. And the ratio (namely, percent modulation) of the "on" period of a vertical transistor is determined by making into the "on" period of the top transistor of each phase, and the "off" period of a bottom transistor the period when a triangular wave exceeds a command value. The percent modulation d1 of an inverter INV1 is shown in drawing 4 (a), and the percent modulation d2 of an inverter INV2 is shown in drawing 4 (b).

[0035] Thus, neutral point potential is determined by percent modulation and the ratio of this neutral point potential and a capacitor electrical potential difference is determined by percent modulation. Furthermore, the potential difference of two neutral point potentials is the electrical potential difference E of Dc-battery B. Therefore, the following relation between the capacitor electrical potential differences Vc is with percent modulation.

[0036] $Vc=E/(d1-d2)$

Then, the capacitor electrical potential difference Vc can be determined by controlling the percent modulation of both the inverters INV1 and INV2.

[0037] In addition, in the above-mentioned example, the switching transistor was turned on and off as the dish for the dead time to the subcarrier period Ts of an inverter. namely, -- the case of 50% of duty ratio -- a vertical transistor -- 50% -- it was made to carry out period ON. However, in order to abolish the penetration current in a switching period completely, the dead time Td which turns off a vertical transistor both is formed in many cases. In this case, an above-mentioned formula is rewritten as follows and applied.

[0038] $Vc=E/\{(d1-Td/Ts)-(d2+Td/Ts)\}$

Thus, when preparing a dead time, the capacitor electrical potential difference Vc can be determined by controlling percent modulation d1 and d2.

[0039] Furthermore, the modification of further others is shown in drawing 5 . In this example, it has three, M1, M2, and M3, as a motor coil. And between the neutral points of the motor coils M1 and M2 is connected with a dc-battery B1, and between the neutral points of the motor coils M2 and M3 is connected by dc-battery B-2. Moreover, the output of an inverter INV1 is connected to the motor coil M1, the output of an inverter INV2 is connected to the motor coil M2, and the output of an inverter INV3 is connected to the motor coil M3. And the both ends of Capacitor C are connected to the input of inverters INV1, INV2, and INV3.

[0040] such a system -- setting -- the output voltage of Capacitor C -- when percent modulation of d2 and an inverter INV3 is set [the output voltage of Vc and a dc-battery B1 / the output voltage of E1 and dc-battery B-2 / the percent modulation of E2 and an inverter INV1] to d3 for the percent modulation of d1 and an inverter INV2, there is the following relation to these.
[0041] Vc=E1/(d1-d2)=E2/(d2-d3)
Therefore, the desired capacitor electrical potential difference Vc can be obtained by controlling percent modulation d1, d2, and d3, as this formula is satisfied. Moreover, the charge between a dc-battery B1 and B-2 can be conveyed by changing the value of E1/(d1-d2) and E2/(d2-d3).
[0042] In addition, although carried out to three of the motor coils M1, M2, and M3, control same also as four or more can be performed. Moreover, two or more motor coils may constitute one motor, or may constitute two or more motors.
[0043] "Control of amplitude maximum", next control of the current amplitude maximum in this system are explained. This is attained by changing distribution of the current to two motor coils M1 and M2.
[0044] Before explaining the example of control concerning "effectiveness of operation gestalt" operation gestalt, simulation shows the relation between a motor output and the phase current, and the current reduction effectiveness of this invention is shown.
[0045] The following procedures performed this simulation. First, the phase current iu1 of one phase (here u phase) is divided into the average (dc component) idc in one revolution, and the other component (alternating current component) iac. Furthermore, about the alternating current component iac, the function g (theta) standardized with the amplitude Iac is introduced.
[0046] Namely, [Equation 1]

$$
\begin{aligned}
i_{u1} &= i_{ac} + i_{dc} && (1)\\
i_{dc} &= \int_0^{2\pi} i_{u1}\, d\theta && (2)\\
i_{ac} &= i_{u1} - i_{dc} && (3)\\
I_{ac} &= \max_{\theta}(i_{ac}) - \min_{\theta}(i_{ac}) && (4)\\
g(\theta) &= i_{ac}/I_{ac} && (5)
\end{aligned}
$$

It carries out.
[0047] It continues and an electrical potential difference Vw is defined from the relation between the cell voltage E of this system, and the capacitor electrical potential difference Vc. This is because the electrical potential difference on which the amplitude Iac of the phase current subtracted cell voltage E from the capacitor electrical potential difference Vc becomes maximum. Moreover, it is assumed that the electrical potential difference vv impressed to each coil at coincidence changes by the above-mentioned current iac and fixed phase contrast (power-factor cosphi).
[0048] Namely, [Equation 2] Vw=Vc-E (6)
vv=Vwg (theta+phi) (7)
It carries out.
[0049] Moreover, since six coils have the relation with the work which each coil considers as the motor output Wo, it can arrange like a degree type.
[0050]
[Equation 3]

$$W_o = 6\frac{1}{2\pi}\int_0^{2\pi}(i_{ac}+i_{dc})v_v\,d\theta \quad (8)$$

$$= 6\left(\frac{1}{2\pi}\int_0^{2\pi} i_{ac}v_v\,d\theta + \frac{1}{2\pi}\int_0^{2\pi} i_{dc}v_v\,d\theta\right) \quad (9)$$

$$= 6\left(\frac{1}{2\pi}\int_0^{2\pi} i_{ac}V_w g(\theta+\phi)\,d\theta + 0\right) \quad (10)$$

$$= 6\frac{1}{2\pi}I_{ac}V_w\int_0^{2\pi} g(\theta)g(\theta+\phi)\,d\theta \quad (11)$$

$$I_{ac} = \frac{2\pi}{6}\frac{W_o}{V_w\int_0^{2\pi} g(\theta)g(\theta+\phi)\,d\theta} \quad (12)$$

Moreover, it can be approximated with Wo=ieE under the condition that a motor output has fully small loss. A degree type is obtained from this relation.
[0051]
[Equation 4] ie=Wo/E (13)
As mentioned above, the current which flows each phase coil uses Iac and ie which are calculated by the formula (12) and (13), and is searched for by the degree type. However, the amount of [of ie] ripple is not taking into consideration.
[0052]
[Equation 5]

$$i_{max} = \max_{\theta}(I_{ac} + i_e/3) \quad (14)$$

Next, the conditions used for analysis are shown. Cell voltage E=42V Or 105V, capacitor electrical-potential-difference Vc=210V (rate Vc/Eof pressure up = 5 or 2), and power-factor costheta=0.8 show the difference arising from the energization approach of the maximum of the magnitude of the alternating current amplitude to the motor output Wo.
[0053] This result is shown in drawing 6 - drawing 8 . These drawings show the difference in the phase current maximum by the difference in the rate of a pressure up, phase current maximum (imax) and a continuous line show phase current maximum, and the wavy line shows [the axis of abscissa / the motor output and the axis of ordinate] the dc component of the phase current maximums (ie/3).
[0054] The phase current maximum at the time of energization of the former [drawing 6] and drawing 7 show the phase current maximum at the time of the maximum control energization by 0 phase ripple non-permissive conditions, and drawing 8 shows the phase current maximum at the time of the maximum control energization approach (4.2.2 knots) in 0 phase ripple permissive conditions.
[0055] These drawings show the following things.
[0056] - In any case, the magnitude of the phase current has the large ratio of the dc component which changes with the rates of a pressure up a lot, and the one where the rate of a pressure up is higher occupies at the phase current.
[0057] - The depressor effect of the magnitude of the phase current by the difference in the electrization can be checked again.
[0058] - Wo=40kW and a pressure-up ratio -- when 5 times compare the maximum (an alternating current component, dc component) of phase voltage, in the conventional energization of drawing 6 , it is [at maximum 477A (159,317A) and drawing 7] 402A (85,317A) in 454A (136,317A) and drawing 8 .
[0059] The conventional energization approach of the 2YDC(s) good transformation inverter shown in "explanation of conventional energization approach which is to base of this invention" drawing 6 is explained. The phase currents iu1, iv1, iw1, iu2, iv2, and iw2 usually passed have ie and the alternating current amplitude expressed with A and the Rota rotational frequency by the 2YDC(s) good transformation inverter shown in drawing 3 , and an angle of rotation is expressed with omega, theta (theta=omegat), then a degree type in the zero phase current, respectively.
[0060]
[Equation 6]

$$i_{u1r} = A\sin(\theta) + i_e/3 \quad (15)$$
$$i_{v1r} = A\sin(\theta - \frac{2\pi}{3}) + i_e/3 \quad (16)$$
$$i_{w1r} = A\sin(\theta - \frac{4\pi}{3}) + i_e/3 \quad (17)$$
$$i_{u2r} = A\sin(\theta) - i_e/3 \quad (18)$$
$$i_{v2r} = A\sin(\theta - \frac{2\pi}{3}) - i_e/3 \quad (19)$$
$$i_{w2r} = A\sin(\theta - \frac{4\pi}{3}) - i_e/3 \quad (20)$$

Here, when A=1(A) ie=3(A), formula (15) - (20) has the relation of drawing 9 . however, drawing 9 -- iu1 and iu2 from an upper case -- the 4th step and the last stage have shown [the 1st step and the d shaft currents id1 and id2 after the sum of the current of iu1 and iu carries out / each current / dq shaft conversion of the 2nd step and the phase current / the 3rd step and the q shaft currents iq1 and iq2] 1 (part for plane 1)/3 of the zero phase current ie.
[0061] Here, if reluctance torque is not considered, they are the current component (in this case, since the magnet location is not put into analysis, iu1+iu2 can say it also as the current component which contributes to motor torque) which iq1+iq2 contributes to motor torque, and the current on which ie flows between a cell and a capacitor. And the maximum of the magnitude of the phase current at this time is 2.00 (A). The conditions of the current for generating motor driving torque among the relation of drawing 9 and the current between a cell and a capacitor can be written by the formula (21).
[0062]
[Equation 7]

$$\begin{pmatrix} 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 \\ 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 \end{pmatrix} \begin{pmatrix} i_{u1r} \\ i_{v1r} \\ i_{w1r} \\ i_{u2r} \\ i_{v2r} \\ i_{w2r} \end{pmatrix} = \begin{pmatrix} 2A\sin(\theta) \\ 2A\sin(\theta - \frac{2\pi}{3}) \\ 2A\sin(\theta - \frac{4\pi}{3}) \\ i_e \\ -i_e \end{pmatrix} \quad (21)$$

Furthermore, also as follows, a formula (21) is rewritten by introducing a formula (22) and (23). In addition, in a formula (24), id and iq are the current components expressed with dq shaft, and become constant here.
[0063]
[Equation 8]

$$U = \sqrt{\frac{2}{3}} \begin{pmatrix} 1 & -\frac{1}{2} & -\frac{1}{2} \\ 0 & \frac{\sqrt{3}}{2} & -\frac{\sqrt{3}}{2} \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{pmatrix} \qquad (22)$$

$$T(\theta) = \begin{pmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix} \qquad (23)$$

$$\begin{pmatrix} T(\theta) & \begin{pmatrix} 0 \\ 0 \end{pmatrix} & T(\theta) & \begin{pmatrix} 0 \\ 0 \end{pmatrix} \\ \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix} & \begin{pmatrix} \sqrt{3} \\ 0 \end{pmatrix} & \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix} & \begin{pmatrix} 0 \\ \sqrt{3} \end{pmatrix} \end{pmatrix} \begin{pmatrix} U & \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \\ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} & U \end{pmatrix} \begin{pmatrix} i_{u1r} \\ i_{v1r} \\ i_{w1r} \\ i_{u2r} \\ i_{v2r} \\ i_{w2r} \end{pmatrix} = \begin{pmatrix} i_d \\ i_q \\ i_e \\ -i_e \end{pmatrix} \qquad (24)$$

When phase contrast is between the coils of a motor, the current to energize (when the coil location of a certain star and the coil location of other stars have shifted at the include angle xi) is rewritten like formula (25) - (30), and a formula (24) turns into a formula (31).

[0064]

[Equation 9]

$$i_{u1r} = A\sin(\theta) + i_e/3 \qquad (25)$$

$$i_{v1r} = A\sin(\theta - \frac{2\pi}{3}) + i_e/3 \qquad (26)$$

$$i_{w1r} = A\sin(\theta - \frac{4\pi}{3}) + i_e/3 \qquad (27)$$

$$i_{u2r} = A\sin(\theta + \xi) - i_e/3 \qquad (28)$$

$$i_{v2r} = A\sin(\theta + \xi - \frac{2\pi}{3}) - i_e/3 \qquad (29)$$

$$i_{w2r} = A\sin(\theta + \xi - \frac{4\pi}{3}) - i_e/3 \qquad (30)$$

$$\begin{pmatrix} T(\theta) & \begin{pmatrix} 0 \\ 0 \end{pmatrix} & T(\theta+\xi) & \begin{pmatrix} 0 \\ 0 \end{pmatrix} \\ \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix} & \begin{pmatrix} \sqrt{3} \\ 0 \end{pmatrix} & \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix} & \begin{pmatrix} 0 \\ \sqrt{3} \end{pmatrix} \end{pmatrix} \begin{pmatrix} U & \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \\ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} & U \end{pmatrix} \begin{pmatrix} i_{u1r} \\ i_{v1r} \\ i_{w1r} \\ i_{u2r} \\ i_{v2r} \\ i_{w2r} \end{pmatrix} = \begin{pmatrix} i_d \\ i_q \\ i_e \\ -i_e \end{pmatrix} \qquad (31)$$

When A=1(A) ie=3(A) and xi= 30 degrees, formula (25) - (30) has the relation of drawing 10 . Thus, also when the phase contrast of a coil is taken into consideration, it turns out that there is the same relation as drawing 9 .

[0065] The maximum of the phase current is controlled with the operation gestalt of "explanation of 2YDC (s) good transformation inverter of operation gestalt" drawing 7 , without permitting generating of the ripple in the zero phase current.

[0066] That is, with this operation gestalt, maximum amplitude is controlled in the 2YDC(s) good transformation inverter of drawing 3 by adding a predetermined function to the phase currents iu1, iv1, and iw1. And the maximum amplitude of a current is controlled by subtracting the added function from the phase currents iu2, iv2, and iw2, without fluctuating the output torque of a motor. Moreover, the ripple of the zero phase current is not permitted with this operation gestalt.

[0067] In order to decrease the current amplitude, without changing the magnitude of a motor output torque and the zero phase current, the phase currents iu1, iv1, iw1, iu2, iv2, and iw2 need to satisfy the relation of a formula (21). That is, it is necessary to satisfy a degree type (32). The sum of the current of the phase to which each star corresponds is a sine wave, and this formula means that it is equal to that into which total of the current of each phase in each star changed the sign of the value of the zero phase current, or the value of the zero phase current.

[0068]

[Equation 10]

$$\begin{pmatrix} 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 \\ 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 \end{pmatrix} \begin{pmatrix} i_{u1} \\ i_{v1} \\ i_{w1} \\ i_{u2} \\ i_{v2} \\ i_{w2} \end{pmatrix} = \begin{pmatrix} 2A\sin(\theta) \\ 2A\sin(\theta - \frac{2\pi}{3}) \\ 2A\sin(\theta - \frac{4\pi}{3}) \\ i_e \\ -i_e \end{pmatrix} \qquad (32)$$

Since the rank of the matrix of the left part of a formula (32) is 4 here, two free parameters fu (theta) and fv (theta) can be introduced, and it can rewrite to the following sufficient condition so that a formula (32) may be satisfied.
[0069]
[Equation 11]

$$i_{u1} = A\sin(\theta) + i_e/3 + f_u(\theta) \qquad (33)$$

$$i_{v1} = A\sin(\theta - \frac{2\pi}{3}) + i_e/3 + f_v(\theta) \qquad (34)$$

$$i_{w1} = A\sin(\theta - \frac{4\pi}{3}) + i_e/3 + f_w(\theta) \qquad (35)$$

$$i_{u2} = A\sin(\theta) - i_e/3 - f_u(\theta) \qquad (36)$$

$$i_{v2} = A\sin(\theta - \frac{2\pi}{3}) - i_e/3 - f_v(\theta) \qquad (37)$$

$$i_{w2} = A\sin(\theta - \frac{4\pi}{3}) - i_e/3 - f_w(\theta) \qquad (38)$$

$$f_u(\theta) + f_v(\theta) + f_w(\theta) = 0 \qquad (39)$$

$$\int_0^{2\pi} f_u(\theta)\, d\theta = 0 \qquad (40)$$

$$\int_0^{2\pi} f_v(\theta)\, d\theta = 0 \qquad (41)$$

$$\int_0^{2\pi} f_w(\theta)\, d\theta = 0 \qquad (42)$$

Here, fu (theta), fv (theta), and fw (theta) are the parameters (a degree of freedom is 2) which can be used for a design.
[0070] Therefore, the phase currents iu1, iv1, iw1, iu2, iv2, and iw2 can be fluctuated by giving fu (theta), fv (theta), and fw (theta) (a degree of freedom being 2) which fill formula (33) - (42), without fluctuating an output torque and the zero phase current. And the desired end can be attained by choosing fu (theta), fv (theta), and fw (theta) so that the maximum amplitude of the phase currents iu1, iv1, iw1, iu2, iv2, and iw2 may be decreased.
[0071] With the operation gestalt of drawing 8 , conditions are eased, generating of the ripple in the zero phase current is permitted, and the maximum of the phase current is controlled. In this case, the conditions of a formula (39) can be removed. Therefore, the degree of freedom in the case of choosing fu (theta), fv (theta), and fw (theta) spreads. And it becomes possible to make maximum of the phase current smaller.
[0072] Moreover, in above-mentioned explanation, it was premised on that there is no phase contrast between two motor coils M1 and M2. In fact, phase contrast is given and arranged between coils in many cases. In this case, the effect of having given phase contrast is eliminated by giving the phase contrast corresponding to a coil current.
[0073] In having phase contrast xi between the coils of such each star, a formula (31) serves as conditions which change to a formula (21). That is, in order to decrease the current amplitude, without changing the magnitude of motor generating torque or the zero phase current, the phase currents iu1, iv1, iw1, iu2, iv2, and iw2 need to satisfy a formula (43). This formula means that the sum of dq shaft current to which each star corresponds is fixed, and it is equal to that into which total of the current of each phase in each star changed the sign of the value of the zero phase current, or the value of the zero phase current.
[0074]
[Equation 12]

$$\begin{pmatrix} \begin{pmatrix} & T(\theta) & & \begin{pmatrix} 0 \\ 0 \end{pmatrix} & & T(\theta+\xi) & & \begin{pmatrix} 0 \\ 0 \end{pmatrix} \\ \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix} & & & \begin{pmatrix} \sqrt{3} \\ 0 \end{pmatrix} & \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix} & & & \begin{pmatrix} 0 \\ \sqrt{3} \end{pmatrix} \end{pmatrix} \\ \begin{pmatrix} U & \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \\ \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} & U \end{pmatrix} \end{pmatrix} \begin{pmatrix} i_{u1r} \\ i_{v1r} \\ i_{w1r} \\ i_{u2r} \\ i_{v2r} \\ i_{w2r} \end{pmatrix} = \begin{pmatrix} i_d \\ i_q \\ i_e \\ -i_e \end{pmatrix} \quad (43)$$

Here, the following results as well as [as one of the solutions which fills a formula (43)] the above-mentioned case are drawn.
[0075]
[Equation 13]

$$i_{u1} = A\sin(\theta) + i_e/3 + f_u(\theta) \quad (44)$$
$$i_{v1} = A\sin(\theta - \frac{2\pi}{3}) + i_e/3 + f_v(\theta) \quad (45)$$
$$i_{w1} = A\sin(\theta - \frac{4\pi}{3}) + i_e/3 + f_w(\theta) \quad (46)$$
$$i_{u2} = A\sin(\theta + \xi) - i_e/3 + h_u(\theta) \quad (47)$$
$$i_{v2} = A\sin(\theta + \xi - \frac{2\pi}{3}) - i_e/3 + h_v(\theta) \quad (48)$$
$$i_{w2} = A\sin(\theta + \xi - \frac{4\pi}{3}) - i_e/3 + h_w(\theta) \quad (49)$$
$$f_u(\theta) + f_v(\theta) + f_w(\theta) = 0 \quad (50)$$
$$h_u(\theta) + h_v(\theta) + h_w(\theta) = 0 \quad (51)$$
$$\int_0^{2\pi} f_u(\theta)\,d\theta = 0 \quad (52)$$
$$\int_0^{2\pi} f_v(\theta)\,d\theta = 0 \quad (53)$$
$$\int_0^{2\pi} f_w(\theta)\,d\theta = 0 \quad (54)$$
$$\int_0^{2\pi} h_u(\theta)\,d\theta = 0 \quad (55)$$
$$\int_0^{2\pi} h_v(\theta)\,d\theta = 0 \quad (56)$$
$$\int_0^{2\pi} h_w(\theta)\,d\theta = 0 \quad (57)$$
$$V\begin{pmatrix} f_u(\theta) \\ f_v(\theta) \\ f_w(\theta) \end{pmatrix} = -T(\xi)V\begin{pmatrix} h_u(\theta) \\ h_v(\theta) \\ h_w(\theta) \end{pmatrix} \quad (58)$$
$$V = \sqrt{\frac{2}{3}}\begin{pmatrix} 1 & -\frac{1}{2} & -\frac{1}{2} \\ 0 & \frac{\sqrt{3}}{2} & -\frac{\sqrt{3}}{2} \end{pmatrix} \quad (59)$$

Here, fu (theta), fv (theta), fw (theta), hu (theta), hv (theta), and hw (theta) are the parameters which can be used for a design. Furthermore, the function of a formula (33) and (42) fills a formula (44) and (59) at the time of xi= 0 degree.

[0076] And the phase currents iu1, iv1, iw1, iu2, iv2, and iw2 can be fluctuated by giving fu (theta), fv (theta), fw (theta), hu (theta), hv (theta), and hw (theta) which fill formula (44) - (59), without fluctuating an output torque and the zero phase current. Furthermore, the desired end can be attained by making fu (theta), fv (theta), fw (theta), hu (theta), hv (theta), and hw (theta) into the form which can control the maximum of the phase currents iu1, iv1, iw1, iu2, iv2, and iw2.

[0077] Moreover, if conditions are eased and the zero phase current is allowed a ripple current, instead of the conditions of a formula (50) and (51), fu+fv+fw+hu+hv+hw=0 will become conditions.

[0078] The energization approach of being satisfied with xi= 0 degree of phase contrast between "example when not allowing the zero phase current ripple" coils of above-mentioned conditions is acquired by setting up fu (theta), fv (theta), and fw (theta) like formula (60) - (62). In addition, g1 of a formula is the constant put in in order to fulfill the conditions of formula (40) - (42), and is g1=0.867 in this case.

[0079]

[Equation 14]

$$f_u(\theta) = \begin{cases} -0.5A\left(\sin(\theta+\frac{2\pi}{6})-g_1\right) & (0 \le \theta \le \frac{2\pi}{6}) \\ A\left(\sin(\theta)-g_1\right) & (\frac{2\pi}{6} \le \theta \le 2\frac{2\pi}{6}) \\ -0.5A\left(\sin(\theta-\frac{2\pi}{6})-g_1\right) & (2\frac{2\pi}{6} \le \theta \le 3\frac{2\pi}{6}) \\ -0.5A\left(\sin(\theta-2\frac{2\pi}{6})-g_1\right) & (3\frac{2\pi}{6} \le \theta \le 4\frac{2\pi}{6}) \\ A\left(\sin(\theta-3\frac{2\pi}{6})-g_1\right) & (4\frac{2\pi}{6} \le \theta \le 5\frac{2\pi}{6}) \\ -0.5A\left(\sin(\theta-4\frac{2\pi}{6})-g_1\right) & (5\frac{2\pi}{6} \le \theta \le 6\frac{2\pi}{6}) \end{cases} \quad (60)$$

$$f_v(\theta) = \begin{cases} A\left(\sin(\theta+\frac{2\pi}{6})-g_1\right) & (0 \le \theta \le \frac{2\pi}{6}) \\ -0.5A\left(\sin(\theta)-g_1\right) & (\frac{2\pi}{6} \le \theta \le 2\frac{2\pi}{6}) \\ -0.5A\left(\sin(\theta-\frac{2\pi}{6})-g_1\right) & (2\frac{2\pi}{6} \le \theta \le 3\frac{2\pi}{6}) \\ A\left(\sin(\theta-2\frac{2\pi}{6})-g_1\right) & (3\frac{2\pi}{6} \le \theta \le 4\frac{2\pi}{6}) \\ -0.5A\left(\sin(\theta-3\frac{2\pi}{6})-g_1\right) & (4\frac{2\pi}{6} \le \theta \le 5\frac{2\pi}{6}) \\ -0.5A\left(\sin(\theta-4\frac{2\pi}{6})-g_1\right) & (5\frac{2\pi}{6} \le \theta \le 6\frac{2\pi}{6}) \end{cases} \quad (61)$$

$$f_w(\theta) = \begin{cases} -0.5A\left(\sin(\theta+\frac{2\pi}{6})-g_1\right) & (0 \le \theta \le \frac{2\pi}{6}) \\ -0.5A\left(\sin(\theta)-g_1\right) & (\frac{2\pi}{6} \le \theta \le 2\frac{2\pi}{6}) \\ A\left(\sin(\theta-\frac{2\pi}{6})-g_1\right) & (2\frac{2\pi}{6} \le \theta \le 3\frac{2\pi}{6}) \\ -0.5A\left(\sin(\theta-2\frac{2\pi}{6})-g_1\right) & (3\frac{2\pi}{6} \le \theta \le 4\frac{2\pi}{6}) \\ -0.5A\left(\sin(\theta-3\frac{2\pi}{6})-g_1\right) & (4\frac{2\pi}{6} \le \theta \le 5\frac{2\pi}{6}) \\ A\left(\sin(\theta-4\frac{2\pi}{6})-g_1\right) & (5\frac{2\pi}{6} \le \theta \le 6\frac{2\pi}{6}) \end{cases} \quad (62)$$

The wave of fu (theta) is shown in drawing 11 and drawing 12 about the case of A=1(A) ie=3(A) as compared with iu1. The thing and drawing 12 by which drawing 11 set the scale of the axis of ordinate of drawing of fu (theta) and drawing of iu1 are expanded in order to make the wave of fu (theta) legible. The wave of fu (theta) starts the peak part of a sine wave by width of face 60 degrees, can be located in a line in it in order by the side of forward side negative side forward, and is the wave which set up the magnitude of a negative side the twice by the side of forward from drawing. That is, it is the wave which controls the place of the maximum peak of iu1 most.

[0080] Therefore, by adding fu (theta), fv (theta), and fw (theta) of such a form to a sign curve, about the phase current, maximum current can be controlled and there is no change of an output torque based on this. Furthermore, the conditions of not generating the zero phase current are also filled with this example.

[0081] Furthermore, the result of having used the conditions of formula (60) - (62) is shown in drawing 13 . Drawing shows the following things.

[0082] - The zero phase current zero phase current is ie=3(A), and a ripple component is not contained.

[0083] - The current (iu1+iu2) which generates torque motor torque is equivalent to drawing 9 , and has generated the torque as an intention.

[0084] - The maximum of the magnitude of the magnitude phase current of the phase current is 1.866 (A). The component according [the component according / the items of magnitude / to an alternating current] to 0.866A and a direct current is 1A.

[0085] Thus, the maximum of the phase current can be controlled, without affecting the zero phase current and a motor output torque by using fu (theta), fv (theta), and fw (theta) which are shown in formula (60) - (62).

[0086] Moreover, xi= 0 degree shows the case where the alternating current amplitude is modulated by the 3 times as many higher harmonic as this, as other examples when not allowing the zero phase current a ripple.

[0087] That is, the wave of fu (theta) is shown in drawing 14 about the case of A=1(A) ie=3(A) as compared with iu1. This wave is the wave which is a sine wave with one 3 times the frequency of this, and modulated the alternating current wave amplitude from the first like a degree type.

[0088]

[Equation 15]

$$i_{u1} = (1 + \alpha \sin(3\theta))A \sin(\theta) + i_e/3 \quad (63)$$

$$i_{u2} = (1 - \alpha \sin(3\theta))A \sin(\theta) - i_e/3 \quad (64)$$

Furthermore, a formula (63) and (64) can be arranged as follows.
[0089]
[Equation 16]

$$i_{u1} = A \sin(\theta) + i_e/3 + \alpha \sin(3\theta) A \sin(\theta) \quad (65)$$

$$i_{u2} = A \sin(\theta) - i_e/3 - \alpha \sin(3\theta) A \sin(\theta) \quad (66)$$

Here, if it sets with fu(theta) =alphasin(3theta) Asin (theta), the conditions of formula (33) - (42) will be satisfied. That is, the following results are obtained by setting it as fu(theta) =alphasin(3theta) Asin (theta).
[0090] Drawing 14 shows this fu (theta). Furthermore, the result of having used this fu (theta) is shown in drawing 15 . Drawing shows the following things.
[0091] - The average of the zero phase current zero phase current is ie=3(A). The magnitude is 3 times the amplitude of added fu (theta).
[0092] - The current (iu1+iu2) which generates torque motor torque is equivalent to drawing 9 , and has generated the torque as an intention.
[0093] - The maximum of the magnitude of the magnitude phase current of the phase current is 1.872 (A). The component according [the component according / the items of magnitude / to an alternating current] to 0.872A and a direct current is 1A.
[0094] Next, a result when 30 degrees of phase contrast shift to the coil location between each star (xi= 30 degrees) is shown in drawing 16 . This drawing shows the following things.
[0095] - The zero phase current zero phase current is ie=3(A), and a ripple component is not contained.
[0096] - The current (id and iq) which generates torque motor torque is equivalent to drawing 9 , and has generated the torque as an intention.
[0097] - The maximum of the magnitude of the magnitude phase current of the phase current is 1.866 (A). The component according [the component according / the items of magnitude / to an alternating current] to 0.866A and a direct current is 1A.
[0098] - the wave of the phase current -- the command value used here is a wave which changes steeply, in order to control the magnitude of a current. However, in being actual, it realizes by filtering this and removing a high frequency component. However, the depressor effect of a current worsens a little in that case.
[0099] It is "example in case of allowing the zero phase current ripple" xi=0 degree, and is the conditions which allow a zero phase current ripple, and one of the energization approaches which can control the magnitude of the phase current is passing fu (theta), fv (theta), and fw (theta) like formula (67) - (69). In addition, g2 of a formula is the constant put in in order to fulfill the conditions of formula (40) - (42), and is g2=-0.637 in this case.
[0100]
[Equation 17]

$$f_u(\theta) = \begin{cases} -A \sin(\theta) - g_2 & (0 \le \theta \le \pi) \\ A \sin(\theta) - g_2 & (\pi \le \theta \le 2\pi) \end{cases} \quad (67)$$

$$f_v(\theta) = \begin{cases} A \sin(\theta - \frac{2\pi}{3}) - g_2 & (0 \le \theta \le 2\frac{2\pi}{6}) \\ -A \sin(\theta - \frac{2\pi}{3}) - g_2 & (2\frac{2\pi}{6} \le \theta \le 5\frac{2\pi}{6}) \\ A \sin(\theta - \frac{2\pi}{3}) - g_2 & (5\frac{2\pi}{6} \le \theta \le 2\pi) \end{cases} \quad (68)$$

$$f_w(\theta) = \begin{cases} -A \sin(\theta - \frac{4\pi}{3}) - g_2 & (0 \le \theta \le \frac{2\pi}{6}) \\ A \sin(\theta - \frac{4\pi}{3}) - g_2 & (\frac{2\pi}{6} \le \theta \le 4\frac{2\pi}{6}) \\ -A \sin(\theta - \frac{4\pi}{3}) - g_2 & (4\frac{2\pi}{6} \le \theta \le 2\pi) \end{cases} \quad (69)$$

The wave of fu (theta) is shown in drawing 17 about the case of A=1(A) ie=3(A) as compared with iu1. Furthermore, the result of having used the conditions of formula (67) - (69) is shown in drawing 18 .

Drawing shows the following things.
[0101] - Although the average of the zero phase current zero phase current is ie=3(A), a ripple component is contained and the magnitude is 0.46A.
[0102] - The current (iu1+iu2) which generates torque motor torque is equivalent to drawing 9 , and has generated the torque as an intention.
[0103] - The maximum of the magnitude of the magnitude phase current of the phase current is 1.63 (A). The component according [the component according / the items of magnitude / to an alternating current] to 0.63A and a direct current is 1A.
[0104] Next, the case where a 6 times as many higher harmonic as this is added to the zero phase current as an example of the approach of others in the case of allowing a ripple at xi= 0 degree is shown. The wave of fu (theta) is shown in drawing 19 about the case of A=1(A) ie=3(A) as compared with iu1. In addition, the value optimized so that the phase current might become min is used for the amplitude of a higher harmonic.
[0105] Furthermore, the result of having used this fu (theta) is shown in drawing 20 . Drawing shows the following things.
[0106] - As for the zero phase current zero phase current, a ripple component is contained, as for the average although it is ie=3(A). The magnitude is 3 times the amplitude of added fu (theta).
[0107] - The current (iu1+iu2) which generates torque motor torque is equivalent to drawing 9 , and has generated the torque as an intention.
[0108] - The maximum of the magnitude of the magnitude phase current of the phase current is 1.96 (A). The component according [the component according / the items of magnitude / to an alternating current] to 0.96A and a direct current is 1A.
[0109] thus, low cost-ization of a system is realizable, maintaining equivalency ability, since the current capacity of a device can be lowered without being able to control the maximum current value of the phase current, without being accompanied by the change in torque, and spoiling the function as a motor, if it is alike and is based on the above-mentioned operation gestalt. By controlling a torque ripple, the function of a motor is made to sufficient thing.
[0110] Moreover, a high frequency component needs to be overlapped on current control at a current. For this reason, it is necessary to control a current to a RF region. However, more effective control is attained by changing control at a rotational frequency.
[0111] That is, since the control frequency band from the first is low in order to perform amplitude maximum control in the low rotation region where a current value is large, control does not become extremely difficult even if it superimposes a higher harmonic. On the other hand, in a high rotation region, in order to use a conventional method, the control problem at the time of the above-mentioned RF superposition is not generated. Furthermore, in a middle turn field, suitable control can be performed by controlling the ripple of the zero phase current.
[0112] Current control is realizable with the change of such control, avoiding the problem on control by current control.
[0113] "One apparatus driving gear" As mentioned above, according to this operation gestalt, it has two three phase coils 24 and 26, and the system which constitutes one motor by this is shown. And it is suitable to an inverter and really form such a motor.
[0114] The overall configuration is shown in drawing 21 . An inverter 110 is arranged at the one side in a case 100. For example, this inverter 110 contains two inverter circuits 30 and 32, and is formed on one substrate 112. An inverter 110 consists of components 114, such as two or more power transistors, and the stator (stator coil) 150 is connected with this inverter 110 with wiring 116. In addition, in drawing, although only one wiring 116 was shown, each of the outgoing end of an inverter 110 is connected to each input edge of a stator 150. Moreover, between partition 120 and a substrate 112, the cooling plate 118 including a cooling water way is arranged inside, and the component 114 is cooled by this.
[0115] A bearing (bearing) 122 is formed in the partition 120 of a case 100 in the core, and a shaft 130 is supported to revolve here. In the opposite side of the inverter 110 of a case 100, a bearing (bearing) 124 is formed in the location which a shaft 130 penetrates, and the shaft 130 is projected from the case 100 through this bearing 124.
[0116] In the pars intermedia in the case of a shaft 130, Rota 140 is arranged, and the stator 150 is arranged so that this Rota 140 may be surrounded. This Rota 140 and stator 150 have the form where a hollow cylindrical stator 150 encloses Rota 140 of a cylindrical shape concentrically, as shown in the right figure of drawing 21 .
[0117] In this example, the stator 150 is divided into four partial stators p1, p2, p3, and p4 in the hoop

direction, and is the motor of four pole pairs (pole). And as for these partial stators p1, p2, p3, and p4, each contains the three phase coils 24 and 26. Therefore, in the partial stator p1, two three phase coils 24 and 26 are formed. And since there are four partial stators, series connection of the coil of each phase is carried out, respectively, and two three phase coils 24 and 26 are the coils of six phases as a whole.
[0118] And the outgoing end of inverter circuits 30 and 32 is connected to six coil ends of these two three phase coils 24 and 26, respectively. This connection is made within a case 100. On the other hand, DC power supply 40 are external and are connected to the terminal for cells of the pair prepared in the case 100 (each is connected at the neutral point of the three phase coils 24 and 26).
[0119] Moreover, in this example, the capacitor 38 is also formed by external. Then, the terminal of a pair connected to the positive-electrode bus-bar 34 and the negative-electrode bus-bar 36 of inverter circuits 30 and 32 is prepared in a case 100, and the external capacitor 38 is connected here. In addition, it is also suitable to hold a capacitor 38 in a case 100. By this, external wiring can be decreased further.
[0120] Moreover, it is necessary to arrange both three phase coils 24 and 26 to no partial stators p1-p4, respectively. For example, the three phase coil 24 may be arranged to the partial stators p1 and p3, and the three phase coil 26 may be arranged to the partial stators p2 and p4. In this case, series connection of each phase coil of the partial stators p1 and p3 is carried out, respectively, and series connection of each phase coil of the partial stators P2 and p4 is carried out, respectively.
[0121] Even if it is this configuration, the number of the edges of the three phase coils 24 and 26 is six, and three outgoing ends of an inverter circuit 30 are connected to three edges of the three phase coil 24, and three outgoing ends of an inverter circuit 32 are connected to three outgoing ends of the three phase coil 26.
[0122] Furthermore, other examples are shown in drawing 22 . In this example, the three phase coils (stator coil) 24 and 26 are divided in the shaft 130 direction of Rota 140, and it is formed. In drawing, left-hand side is the three phase coil 24, and right-hand side is the three phase coil 26. If it is the motor of four pole pairs, the three phase each coils 24 and 26 will be divided into four partial stators, and series connection of the coil of each phase of each partial stator will be carried out. Therefore, the coil of a three phase circuit will be arranged in the two die-length directions of a shaft 130. Also in this configuration, the end winding of the three phase coils 24 and 26 is three at a time, and there is no modification in connection with inverter circuits 30 and 32.
[0123] In addition, although the above-mentioned example explained the motor of four pole pairs, as long as it is two or more pole pairs, any pole pair is sufficient.
[0124]
[Effect of the Invention] As explained above, according to this invention, the pressure up of the power of a cell can be conveyed and carried out to a capacitor by connecting a cell at the neutral point of a coil. And in spite of having such a pressure-up function, the pressure-up converter of another object is unnecessary, and can obtain an inverter one apparatus driving gear.
[0125] Moreover, with the equipment which connects a cell during the neutral point of this invention ****** and the star coil of a pair, the potential difference during the two neutral points of a star coil is only specified, and the average potential (neutral point potential) of each star coil itself can be set as arbitration. Then, broad control can be performed about a capacitor electrical potential difference (inverter input voltage).
[0126] Moreover, the maximum amplitude value of the current supplied to one coil of the coils of the 1st and 2nd stars is decreased, by adding the current corresponding to the decrement to the current supplied to the coil of another side, maximum current can be reduced, an inverter and a coil can also be made small, and a suitable one apparatus driving gear can be obtained.

[Translation done.]

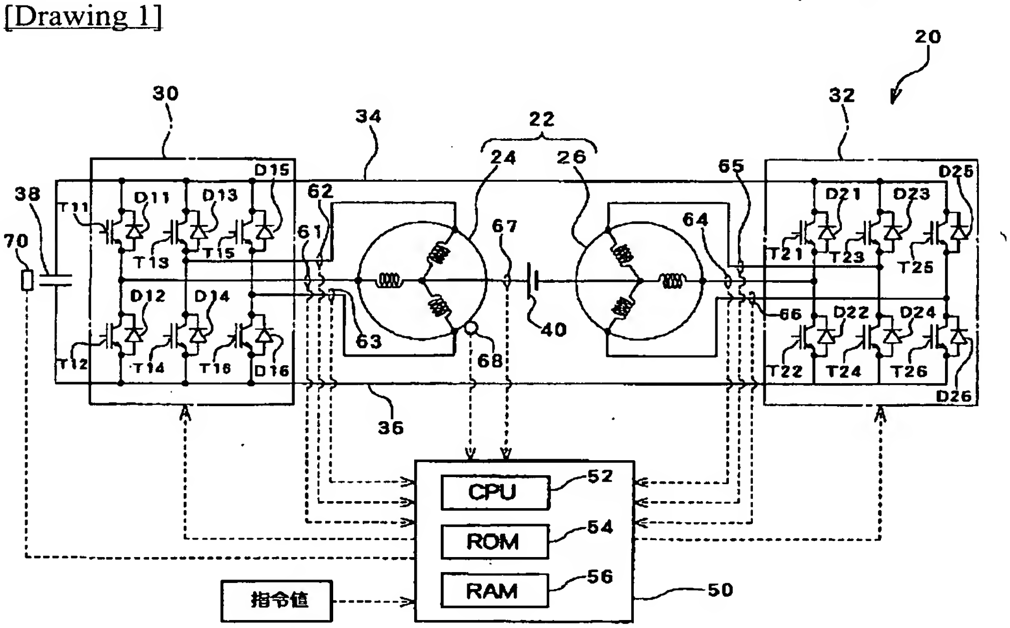
* NOTICES *

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

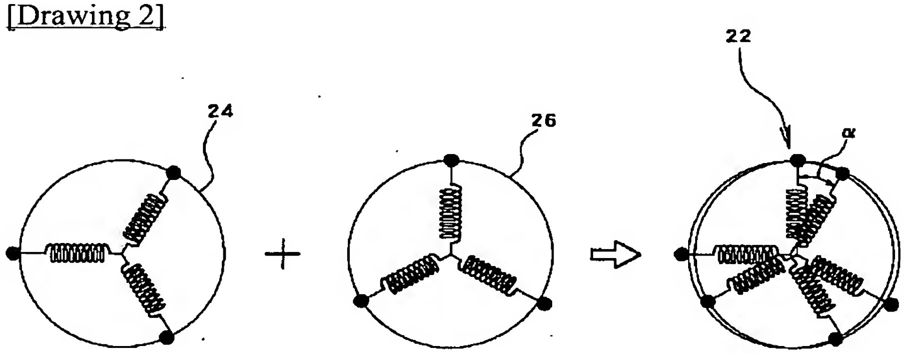
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

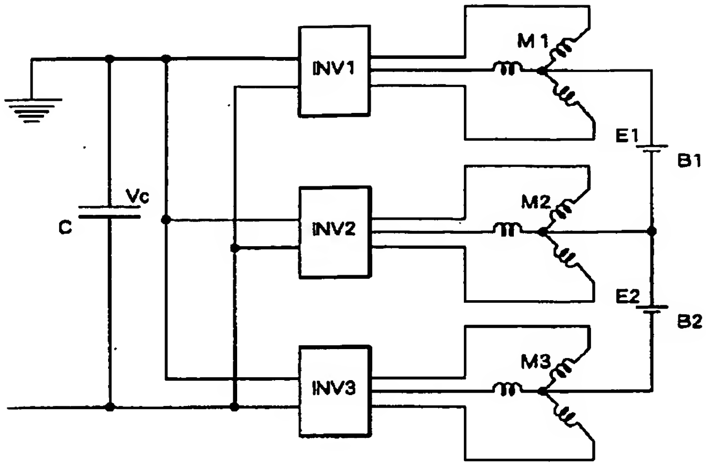
[Drawing 1]



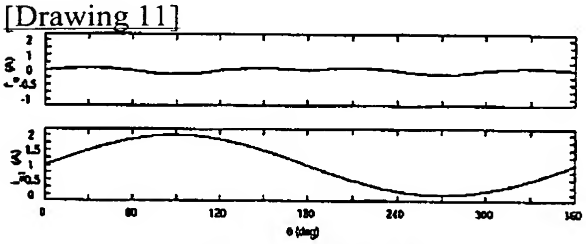
[Drawing 2]



[Drawing 5]

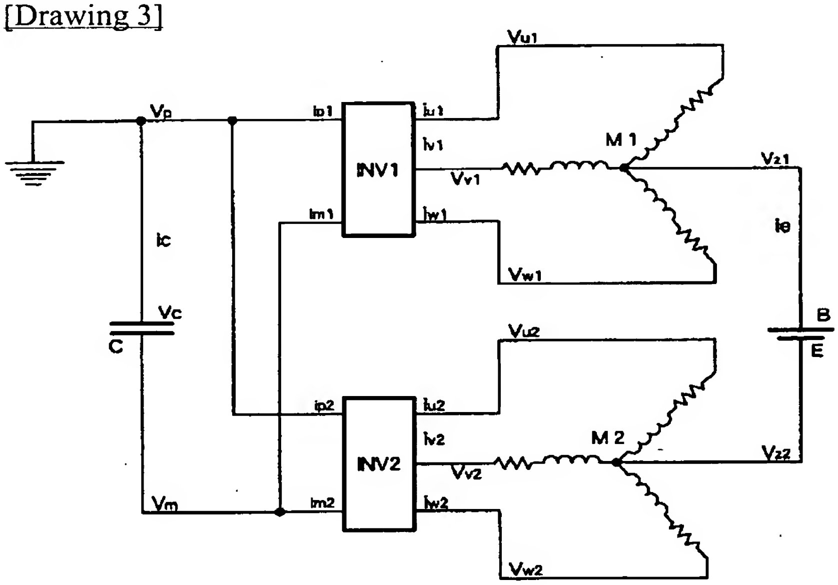


[Drawing 11]

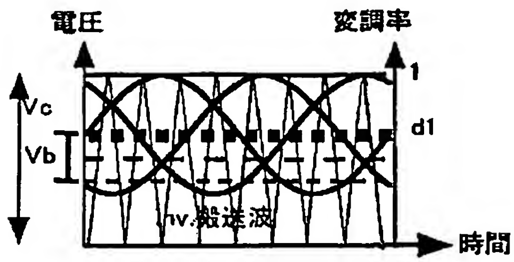


リップル電流を抑制する場合

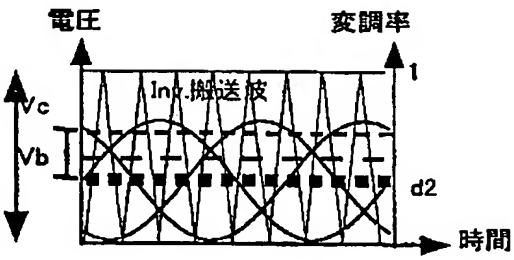
[Drawing 3]



[Drawing 4]

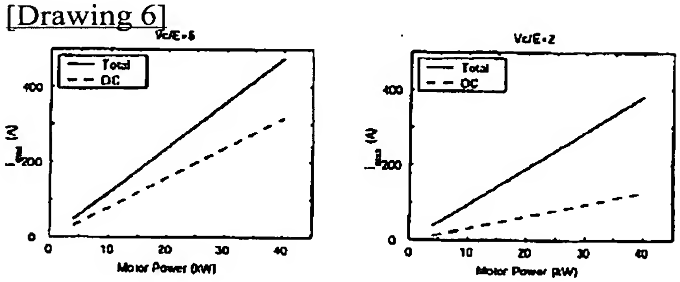


(a)



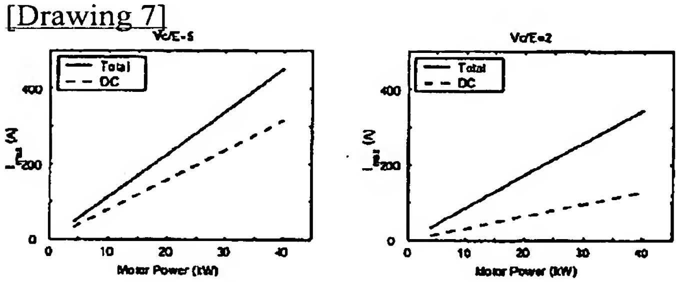
(b)

[Drawing 6]



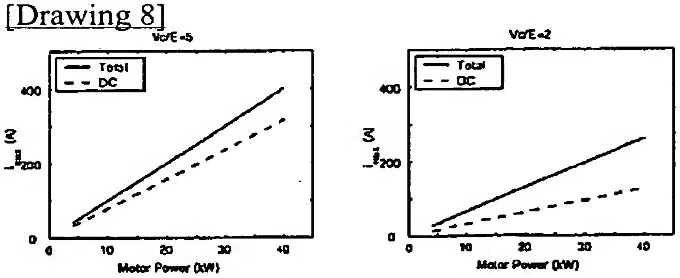
従来通電方法

[Drawing 7]



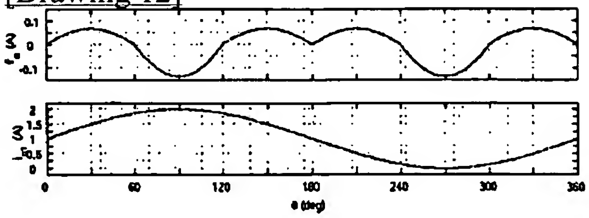
零相リップル非許容

[Drawing 8]



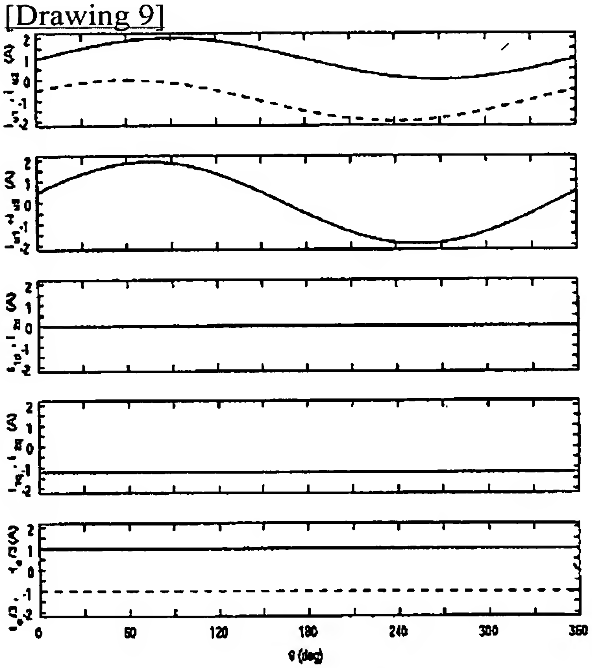
零相リップル許容

[Drawing 12]



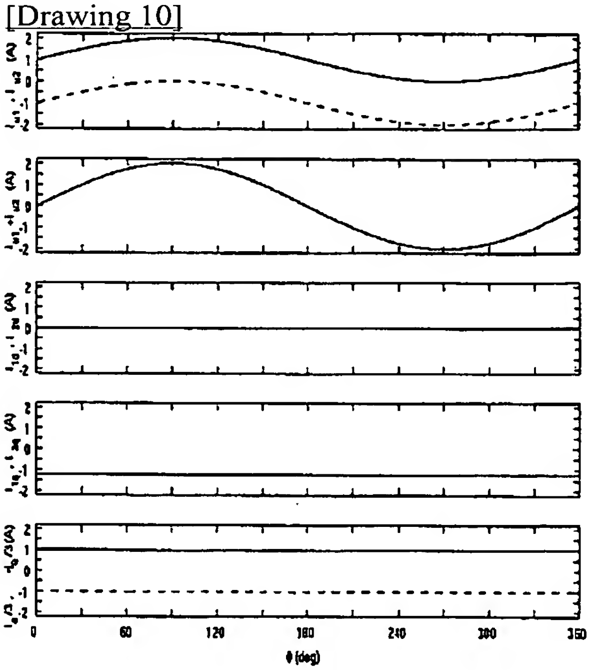
リップル電流を抑制する場合

[Drawing 9]



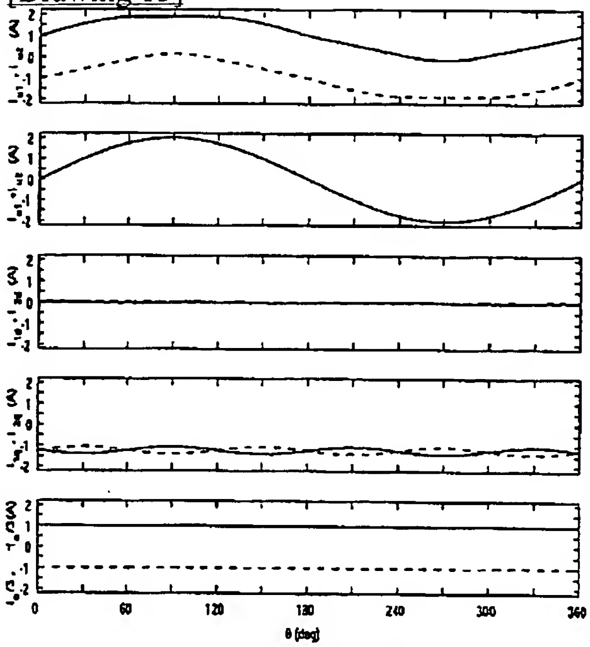
従来の相電流と零相電流など

[Drawing 10]



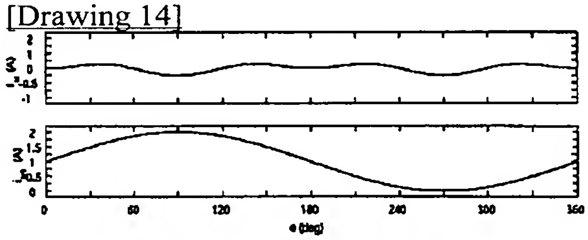
従来の相電流と零相電流など
（コイル間位相差がある場合）

[Drawing 13]



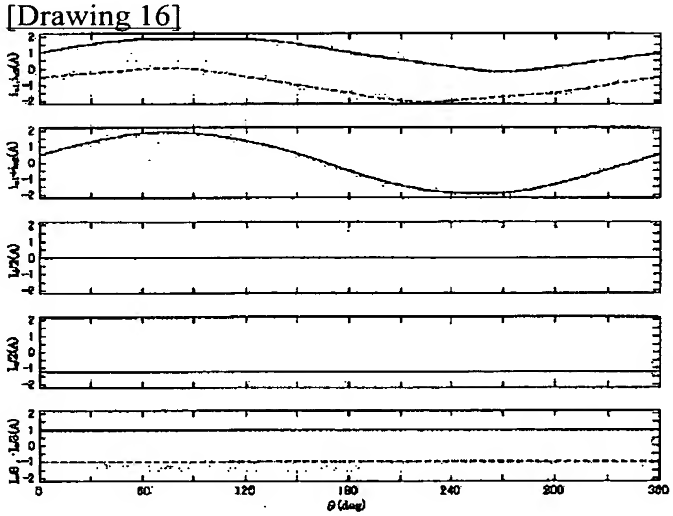
リップル電流を抑制する場合

[Drawing 14]

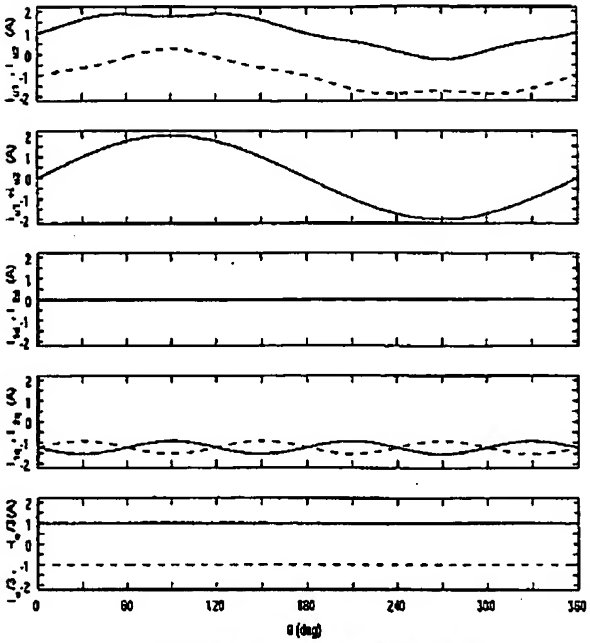


3 倍の高調波で交流振幅を変調する場合

[Drawing 16]

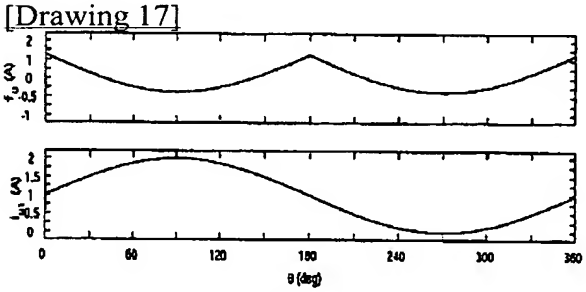


[Drawing 15]



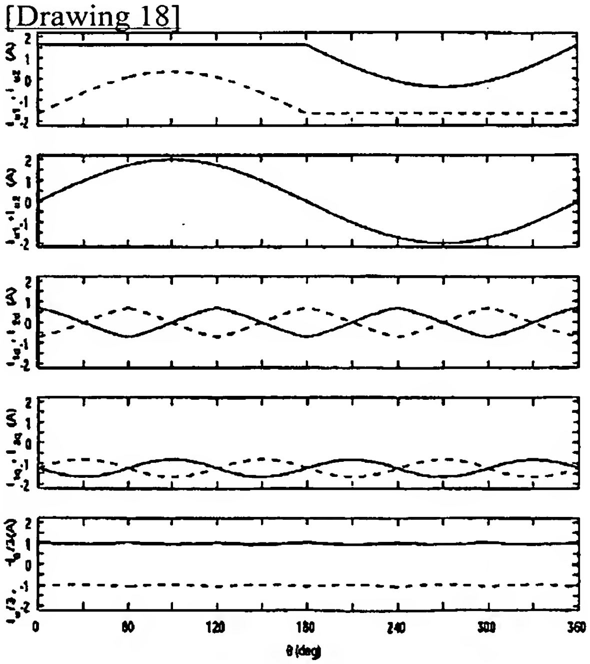
３倍の高調波で交流振幅を変調する場合

[Drawing 17]



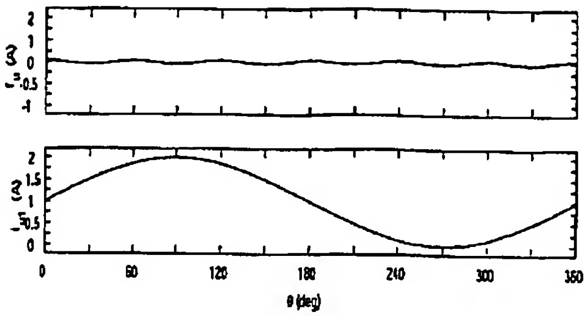
リップル電流を許す場合

[Drawing 18]



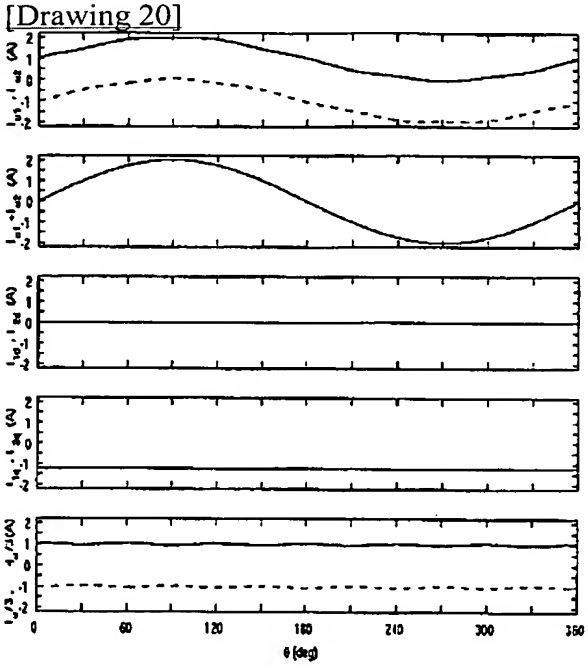
リップル電流を許す場合

[Drawing 19]



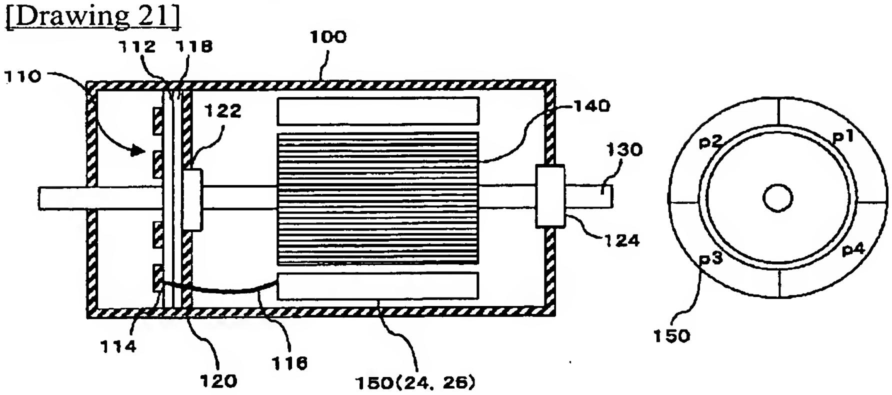
6倍の高調波を加える場合

[Drawing 20]

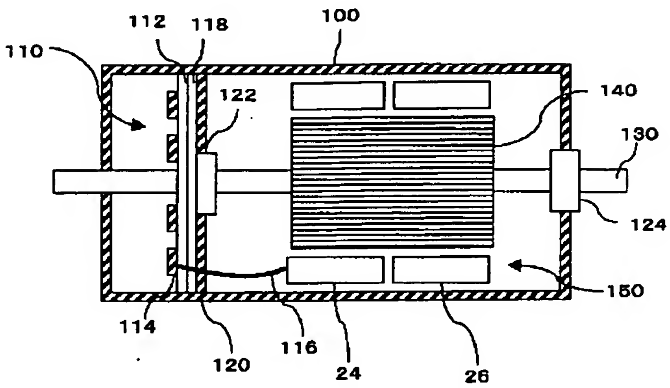


6倍の高調波を加える場合

[Drawing 21]



[Drawing 22]



[Translation done.]